

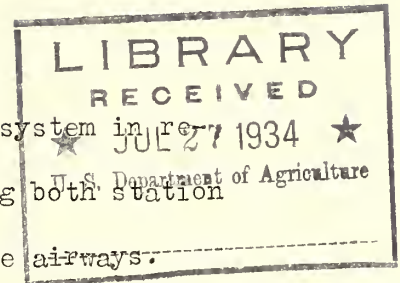
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AIRWAYS ANEROID BAROMETRY.



1. It is necessary to bring about a uniform system in regard to the usage of aneroid barometers for obtaining pressures and pressures reduced to sea level over the both station airways.

2. The reasons for initiating this program are:

(a) different methods of setting aneroids are used in different sections of the country, some of which are unsatisfactory; (b) the readings in some cases require variable (sometimes unknown or doubtful) corrections for different conditions, where suitable reduction tables have not been prepared; (c) it is not possible in many cases to obtain both station and sea-level (reduced) pressures under present conditions; (d) fixed arrangements have not been made for periodic checks on aneroid readings. In some sections the practice of "setting the aneroid to sea level" is followed. This practice which has not at any time been officially authorized by the Weather Bureau is unsound for two reasons, viz., setting an aneroid barometer is likely to disturb the original calibrations; the amount to be added to reduce station pressure to sea level is in general not a constant but rather a variable quantity depending upon the prevailing pressure and the temperature assumed for the hypothetical air column, as will be apparent upon inspection of station reduction tables.

3. The program envisages three important cases, with different procedures for each: case (1) an intermediate station having an aneroid but not a mercurial barometer, and not near a Weather Bureau station having a mercurial barometer; case (2) an airport.

station manned by airways observers having an aneroid but not a mercurial barometer and near a Weather Bureau station having a mercurial barometer; case (3) an airport or intermediate station having both an aneroid and a mercurial barometer. These three cases are treated separately in the following:

CASE (1) -- INTERMEDIATE STATION WITH ONLY A ANEROID BAROMETER AND NOT NEAR A WEATHER BUREAU STATION EQUIPPED WITH A MERCURIAL BAROMETER.

4. Briefly, the plan to be pursued in this case is to replace gradually the aneroids now at these stations with the same or other aneroids set to read nearly actual pressure and with known instrumental corrections so that one may thus obtain "actual and station pressures" from which by suitable tables the reduction of pressure to sea level can be accomplished.

PROCEDURE TO OBTAIN STATION PRESSURE.

5. The following scheme outlined in detail for one station as an example may, and should, if possible, be carried out with a number of stations simultaneously. Each General Supervising Weather Bureau Airport Station will decide which intermediate airways station should be first provided with a corrected aneroid barometer. A tentative "station elevation" will be adopted for the airways station in question. This will be taken as "8 feet above the part of the airport at which landings are most frequently made" in order that "station pressures" will be directly comparable with pilots' altimeter readings. If the station is not at an airport or an intermediate field, the "station elevation" tentatively adopted will be the height of the aneroid barometer.

6. The supervising official will next select a first order Weather Bureau or airport station (or his own station), having an elevation

within 1,000 feet of the elevation of the intermediate station. This first-order station is to be designated as a "cooperating depository station" where the aneroid will be shipped if necessary for comparative readings with a mercurial barometer. If practicable the "cooperating depository station" should be chosen so that in shipping the aneroid by mail between this station and the intermediate station the aneroid will not be subject to changes of more than plus or minus one inch in pressure. The results of the comparative readings will be entered on Form 1027B and will give the "correction for instrumental error." This will be carried forward to Form 1059-A. It is desired that requests upon other stations for comparisons and deposit be limited to such cases as are obviously advantageous by reason of more favorable altitudes. First order Weather Bureau Stations are authorized to cooperate with general supervising airways officials where necessary. If for reasons not now foreseen a station should not be in a position to comply with a request for cooperation, the Central Office should be informed.

7. If upon first comparing the readings between the aneroid and a mercurial barometer the correction is found to exceed 0.20 inch, the Weather Bureau official charged with the duty of making the readings is authorized to set the barometer to a reasonably close agreement with the actual pressure as early as practicable before making the regular comparative readings. Any resetting thus made should be indicated by an explanatory note in the space for remarks on Form 1027-B. The barometer will not thereafter be set without specific authority from the Central Office. If the aneroid is reset

under the conditions stated above the comparative readings should not ordinarily be begun for at least two days after the resetting. Comparative readings will be made and recorded on Form 1027-B according to instructions thereon, the aneroid being hung on a wall within a few feet of the level of the ivory point of the mercurial barometer used for comparison. Care must be taken that the proper corrections are applied to the mercurial barometer readings, so that the actual pressure and not the station pressure is employed as a basis for comparisons. That is, the corrections given on Form 1059 for scale error, capillarity, and the gravity corrections for latitude and altitude for the mercurial barometer together with the temperature correction shall be added algebraically to the observed reading to obtain "actual pressure."

8. Comparative readings will be made ordinarily over a period of at least two weeks by which time it is expected that the instrumental correction will become essentially constant. If the instrument is not sufficiently seasoned in this time, a longer period of readings may be necessary. The "mean correction for instrumental error" computed on Form 1027-B should therefore be based on the later comparisons which should not show important systematic deviations or large fluctuations with time. (Note. Most aneroids are likely to change their correction with lapse of time. This change is greatest during the first few months but may continue for a year or even more. They may also require a new correction when moved permanently to an elevation differing by several thousand feet from the former one because they then undergo a new seasoning process. For example, aneroids shipped from Washington, D. C., to Cheyenne, Wyo., (6,088 feet) were found to have changed their correction by about 0.13 inch after having been seasoned there

for 90 days. If the practice of applying to the readings of the aneroid a correction determined from time to time by the best available means, preferably an adjacent mercurial barometer, is followed, and if the aneroid is not reset, then the series of corrections determined from time to time forms a valuable means of appraisal of its condition.)

9. Promptly upon the satisfactory determination of the "mean correction for instrumental error" and its entry on Form 1027-B, the Official in Charge at the cooperating depository station will sign this form and submit it to the general supervising station and await instructions regarding the shipment of the aneroid.

10. The general supervising official will in the meanwhile obtain by correspondence or otherwise the best available data for entry on the 3rd, 4th, 5th and 6th lines of Form 1059-A, and record these results on duplicate copies of this form. (The expression "tentative station elevation" is used when the elevation above sea level of the "plane 8 feet above the most-used landing point of the airport at the intermediate station" is obtained by an estimate and not an actual survey.) On the basis of these data, the general supervising official will compute the "correction to plane 8 feet above airport" according to instructions on the back of Form 1027-B. This correction will be entered both on the copies of Form 1059-A and on Form 1027-B containing the comparative readings made at the cooperating depository station; finally the "total primary correction" representing the sum of the "correction for instrument error" and the "correction to plane 8 feet above airport" will be entered on the forms, and the latter signed.

Form 1027-B will be mailed to the Central Office by the general supervising official and one copy of Form 1059-A will be forwarded to the intermediate station in question, at the same time ordering the cooperating depository station to ship the aneroid to the intermediate station. The duplicate copy of Form 1059-A will be retained at the general supervising station. In shipping the instrument, care must be exercised not to subject it to severe jars, and it must be carefully packed and labelled "Fragile - Handle with Care."

11. It is expected that the aneroid, if carefully transported, will automatically adjust itself to the elevation at which it is finally hung, and that the "total primary correction" as given on Form 1059-A when applied to the readings of the instrument will give the pressure at the intermediate station corresponding to the plane 8 feet above the landing field.

12. Shipments of aneroid barometers from station to station within the general supervising airway official's district, or shipments to stations outside the district for the purpose of obtaining comparative readings may be made in the discretion of the general supervising airway official without specific authority from the Central Office; but, when a permanent transfer is made of a barometer involving property accountability, specific authority must be requested from the Central Office for formal approval of the transfer. The request should originate with the station charged with the accountability and include serial number of the instrument and the name of the intermediate or airport station to which transferred, as well as the name of the station to be charged with the accountability (see Topics and Personnel for November, 1932, page 324, and Station Regulations (revised) Executive

Section, paragraph 115).

13. Upon return of an uncorrected aneroid from a station provided with a corrected one under the scheme outlined above, it may be subjected to similar comparative readings and then finally sent to any other station in need of a corrected instrument.

14. Note: There may be in the service some aneroids that cannot be set to read actual pressure. Effort will be made to replace these as soon as resources permit. It is planned that in time a few barometers from the Central Office stock shall be stored at several stations at the higher levels. Requisitions made upon the Central Office will then be filled either directly from the Central Office or by transfer from the higher level stations as circumstances may warrant.

15. It should be recognized that time will be required to carry out this program. In addition, it is planned later on to make available for the use of supervising officials on inspection trips mercurial barometers and carrying cases so that comparisons may be made at the airway station itself.

16. Copies of Form 1027-B and Form 1059-A are inclosed. These forms are now available in small quantity on request from general supervising airways officials.

PROCEDURE FOR REDUCTION TO SEA LEVEL.

17. While the aneroid is being subjected to comparative readings, the supervising official will ascertain the following data for the intermediate station and submit them to the Central Office:

- (1) measured difference between the actual elevation of the aneroid hung at the station and the plane 8 feet above the part of the airport there at

which landings are most frequently made. (Data on 6th line of Form 1059-A-Met'l.)

(2) "tentative station elevation"

(i. e. best available estimate or measurement of the elevation above sea level of the "8 foot plane" in question.) (Data on 5th line of Form 1059-A-Met'l.)

(3) mean annual temperature.

(4) remarks showing basis for above items.

The Central Office will either prepare "tentative tables for reduction of pressure to sea level" or will provide instructions for their preparation. Three copies of the tables will be provided, one for the intermediate station, one for the general supervising station and one for the Central Office. The resulting tables will be used at the intermediate station during a trial period to give reduced (sea-level) pressures. These will be compared at the general supervising station with the sea-level pressures interpolated between the smoothed isobars on daily weather map A for a number of varying conditions. (The direct reading of the aneroid corrected by the "total primary correction" as given on Forms 1027-B and 1059-A will be regarded as "station pressure" in entering the reduction tables. for this purpose.) The comparisons in question can be made at the supervising station after receiving the necessary Forms 1130 and other data sheets prepared at the intermediate station.

18. The corrections to the "reduced (sea-level) pressures" as determined from the sea-level isobars on not less than 7 to 10

occasions will be combined to form an average sea-level correction. This average sea-level correction will be reduced back to "station elevation" by using the reduction tables in an inverse manner to that usually employed, thus obtaining a "mean correction" to the station readings. A practical method of accomplishing the reduction of the average sea-level correction back to "station elevation" is illustrated by the following example:

"Average sea-level correction" = +0.083 inch

Average of the mean temperatures
(mean of current and 12-hour
preceding temperatures) used for
the reduction to sea level on all
the occasions upon which the
above "average sea-level cor-
rection" is based = 55°F.

Skeleton table for reduction of pressure to sea level.

Mean Temperature F.	STATION PRESSURE			
		25.60	25.70	
55°		29.96	30.08	

Hence: "Mean correction" = +0.083" $\left(\frac{25.70 - 25.60}{30.08 - 29.96} \right)$

= +0.083" $\left(\frac{0.10}{0.12} \right) = 0.07"$

(In practice, any adjacent values of the sea-level pressure on the line corresponding to the given temperature may be used in forming the indicated ratio.)

The "mean correction" thus found will be added to the "total primary correction" to obtain the "Final Correction" and these with the date of issue will be forwarded to the intermediate station for entry on Form 1059-A. These corrections will also be entered on the duplicate Form 1059-A retained at the supervising station. The "final correction" is used in the regular daily work by adding it algebraically to the direct reading of the aneroid in order to obtain the pressure argument (corresponding to station pressure) required for use with the tables for reduction to sea level.

19. The system of corrections obtained as just indicated will correct for any drift of the aneroid since it was subjected to comparative readings with a mercurial barometer and will cause the corrected pressure (reading of aneroid plus "final correction", algebraically) to represent the pressure corresponding to an elevation above sea level numerically equal to that of the "tentative station elevation."

20. If the "mean correction" first obtained exceeds 0.15 inch, the "tentative station elevation" is considerably in error and will be accordingly corrected and new reduction tables prepared. The method of correcting the "tentative station elevation" is illustrated by the following example:

"Tentative station elevation" = 2750 feet
"Mean correction" = +0.16 inch

Average of the mean temperatures
(mean of current and 12-hour preceding temperatures) used for
the reduction to sea level on all
the occasions upon which the above
"mean correction is based = 300 F.

Referring to Table V, "Pressure, in inches, corresponding to changes of 100 feet in elevation", Circular F, Instrument Division, we find by interpolation that a pressure change of 0.103 inch corresponds to a

change of 100 feet in elevation at a height of 2750 feet and temperature 30°F. Hence the change in elevation corresponding to a change of +0.16 inch pressure is given by

$$\frac{+0.16}{0.103} \times 100 = +155 \text{ feet}$$

The correction to apply to the "tentative station elevation" in order to obtain a closer approximation to true station elevation is of the same algebraic sign as the "mean correction" in pressure, hence is positive in this case. Therefore the corrected "tentative station elevation" is $2750 + 155 = 2905$ feet. This is used as the basis for the new reduction tables. The Central Office should be kept informed of any changes of this nature.

21. The general supervising officials are required to keep a close watch and to make periodic checks at least every two or three months on the reduced (sea-level) pressures finally obtained at the intermediate station by comparing them with the smoothed isobars on daily weather maps. If these reduced pressures show a consistent deviation of significant amount a new "mean correction" and "Final Correction" will be determined and forwarded to the intermediate station for entry on Form 1059-A. This new "final correction" should nullify the observed discrepancies. By keeping duplicate copies of Form 1059-A Met'l. at the supervising station, changes in corrections can be inspected and no misunderstandings between the supervising station and the intermediate stations will occur.

CASE (2) -- AIRPORT STATION WITH ONLY AN ANEROID BAROMETER AND NEAR A WEATHER BUREAU STATION EQUIPPED WITH A MERCURIAL BAROMETER.

22. Briefly, the plan in this case is first to set the aneroid to the "station pressure" obtained at the Weather Bureau station by means of the mercurial barometer, then to make periodic checks by

phone in order that an up-to-date correction may be applied to the aneroid readings, if necessary, to give the "station pressure" observed at the Weather Bureau city office. The airport station will use the same tables for reduction to sea level as are employed at the city office.

23. To carry out this plan, officials at the Weather Bureau station will provide the airport station with a copy of the reduction tables used at their office. At a prearranged time, officials at the city office will determine their station pressure and communicate this result by phone to observers at the airport. The observers at the latter place will set their aneroid to a reading identical with the city office station pressure they have received by phone. The aneroid is not to be reset thereafter without specific authority from the Central Office. For the few days immediately following the resetting it is expected that the instrument will be deviating slightly from city office station pressure. It will therefore be necessary to make fairly frequent comparisons by phone during this time and to apply the difference between the station pressure and the actual reading of the aneroid as a correction to the latter. After the comparisons show the instrument to have settled down to a fairly constant correction, periodic comparisons should be made at least once each week and the correction to give station pressure kept reasonably up-to-date. The current correction should be posted conspicuously next to the aneroid. The sea-level reduction tables may then be used with the corrected aneroid readings regarded as "station pressures."

24. It is expected that in some places the reduction tables may eventually have to be modified in order to take into account local peculiarities.

CASE (3) AIRPORT OR INTERMEDIATE STATION HAVING BOTH AN ANEROID AND A MERCURIAL BAROMETER.

25. The aneroid should first be set to agree with station pressure obtained by means of the mercurial barometer. The aneroid should not be reset thereafter. Corrections to the aneroid should be obtained not less than twice each day by comparative readings with the mercurial barometer and the current values of the correction kept posted conspicuously beside the instrument. The application of these corrections to the direct readings of the aneroid will give "station pressure." The regular sea-level reduction tables may then be used therewith.

